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PLATINUM METALS RECOVERY

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PLATINUM METALS RECOVERY

INTRODUCTION

The platinum group elements (PGEs) refer to six closely related metals: platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir), and osmium (Os). These metals, among the scarcest of all metallic elements, commonly occur together in nature. The platinum group and particularly platinum metal itself are widely used in decorative applications but the principal uses are industrial in nature. Despite their relative scarcity and high price, unique physical and chemical properties have made the PGEs indispensable in a variety of industrial usages.

Exploration for platinum group elements (PGEs) in Canada has accelerated in recent years, stimulated by higher prices, attractive geological potential and favourable investment incentives. This publication provides an overview on processing technology and is intended to support and encourage interest in PGE exploration and development in Canada. Canada has long been an important producer of byproduct PGEs but in light of encouraging exploration results, it could significantly increase production in the next decade.

The preparation of this report involved the participation of several sectors of Energy, Mines and Resources. Coordinators for the report were Dr. L.J. Cabri and W.J.S. Craigen with principal contributors Dr. G. Pouskouleli and A.E. Stemerowicz. In addition, editorial comments and helpful suggestions were provided by G. Bokovay and Dr. G.E. Wittur of the Mineral Policy Sector.

This report is an excerpt from a larger as yet unpublished report dealing with the market aspects of PGEs, the geology, as well as recovery techniques. This report is being issued in this form so that those in Canada interested in exploiting the current demand for PGEs will have ready access to a review of recovery methods in current use.

Keywords: platinum group metals, beneficiation, extraction/refining, process development

RÉCUPÉRATION DES MÉTAUX DU GROUPE PLATINE

INTRODUCTION

Les éléments qui constituent le groupe platine (ÉGP) sont six métaux étroitement liés : le platine (Pt), le palladium (Pd), le rhodium (Rh), le ruthénium (Ru), l'iridium (Ir) et l'osmium (Os). Ces métaux, qui comptent parmi les plus rares de tous les éléments métalliques, se retrouvent souvent ensemble dans la nature. Les métaux du groupe platine et particulièrement le platine lui-même sont fréquemment employés dans des applications décoratives, mais les principaux emplois sont encore ceux de nature industrielle. Malgré leur rareté relative et leur prix élevé, les propriétés physiques et chimiques exclusives des ÉGP les ont rendu indispensables dans une vaste gamme d'utilisations industrielles.

Au Canada, la prospection des ÉGP s'est accélérée au cours des dernières années, stimulée par des prix plus élevés, un potentiel géologique intéressant et des stimulants propres à favoriser les investissements. La présente publication fournit un aperçu de la technologie du traitement et elle vise à soutenir et encourager ceux qui s'intéressent à l'exploration et à la mise en valeur des ÉGP au Canada. Depuis longtemps en effet, ce pays est un important producteur de sous-produits des ÉGP, mais à la lumière des résultats encourageants que les travaux d'exploration ont donnés, la production pourrait y augmenter sensiblement pendant la prochaine décennie.

Plusieurs secteurs d'Énergie, Mines et Ressources ont participé à la préparation du présent rapport. L.J. Cabri et W.J.S. Craigen ont coordonné le rapport, tandis que G. Pouskoupleli et A.E. Stemerowicz en ont été les principaux collaborateurs scientifiques. En outre, des commentaires et des suggestions utiles concernant le contenu ont été fournis par G. Bokovay et G.E. Wittur de la Politique minière.

Le rapport est extrait d'un autre rapport plus volumineux et encore inédit portant sur les marchés des ÉGP, sur leur géologie de même que sur les techniques de récupération. Si le rapport est publié sous la forme actuelle, c'est donc pour permettre à ceux qui au Canada cherchent à profiter de la demande actuelle en ÉGP d'examiner plus facilement les méthodes de récupération employées.

Mots-clés : métaux du groupe platine, enrichissement, extraction-affinage, perfectionnement des procédés

Platinum Metals Recovery

The Beneficiation of PGE-Bearing Ores

Canada

The recovery of platinum-group elements contained in the Sudbury nickel-copper ores accounts for the bulk of primary Canadian production. The balance is made up mostly of PGEs recovered from Thompson, Manitoba nickel ores.

The sulphides in the Sudbury ores occur mainly as chalcopyrite (CuFeS_2), pentlandite ($(\text{Fe}, \text{Ni})_9\text{S}_8$) and two varieties of pyrrhotite (Fe_{1-x}S) - monoclinic pyrrhotite which is magnetic and the hexagonal variety which is non-magnetic. Froth flotation is the principal method employed to recover the various sulphides. Although both varieties of pyrrhotite respond to flotation it has been found advantageous to employ magnetic separation to concentrate the monoclinic pyrrhotite. The order of natural flotability of the various sulphides is as follows: chalcopyrite-pentlandite-pyrrhotite. Thus, when the initial addition of collector (sodium amyl xanthate is employed by Inco) is made to the pulp (ground ore-water mixture), chalcopyrite and pentlandite are floated preferentially into a bulk copper-nickel concentrate. More collector is then added to recover the slower-floating pyrrhotite in a separate concentrate. The bulk concentrate is separated into nickel and copper concentrates by an additional flotation step in which lime and cyanide are added to depress pentlandite.

The platinum-group elements (PGEs) may occur as discrete platinum-group minerals (PGMs) or they may occur within the crystal lattice of certain sulphide minerals such as pentlandite or pyrrhotite as well as in arsenide and sulpharsenide minerals such as nickeline (NiAs) and cobaltite (CoAsS). During processing, the PGEs and much of the PGMs, including any free or partly exposed PGMs, are recovered with the sulphides during sulphide flotation for copper and nickel sulphides and pyrrhotite. However, a significant portion of the PGMs is lost in the tailings and rejects from the pyrrhotite retreatment circuit at Copper Cliff.

Almost all of the copper and about 85 per cent of the nickel is available for recovery by flotation at a coarse grind of 50 to 60 per cent minus 74 micrometres (200 mesh). The balance of the nickel (about 15 per cent) is intimately associated with the pyrrhotite and is only partially liberated when the pyrrhotite concentrate is subjected to fine regrinding and further treatment to recover additional nickel.

A simplified and integrated flowsheet for the three Inco ore concentrating plants currently in operation, is shown in Figure 1. Current PGE recoveries are not published. Prior to 1983, about 70 per cent of the PGEs were recovered in the bulk copper-nickel concentrate from ore assaying 1.4 g/t PGE plus gold. The platinum:palladium:rhodium ratio is about 0.47:0.49:0.04. Mineralogical studies by the Canada Centre for Mineral and Energy Technology (CANMET) determined that sperrylite (PtAs_2) and michenerite (PdBiTe) are the principal minerals of platinum and palladium, respectively. It was also determined that if the crystal lattices of the Sudbury sulphides contained PGEs, their concentration must be less than 1-3 ppm. Additional mineralogical studies carried out by Inco determined that most of the platinum lost in the Copper Cliff mill tailings was in the form of very fine (5-10 micrometres) free particles of sperrylite while non-liberation was a significant factor in palladium mineral losses.

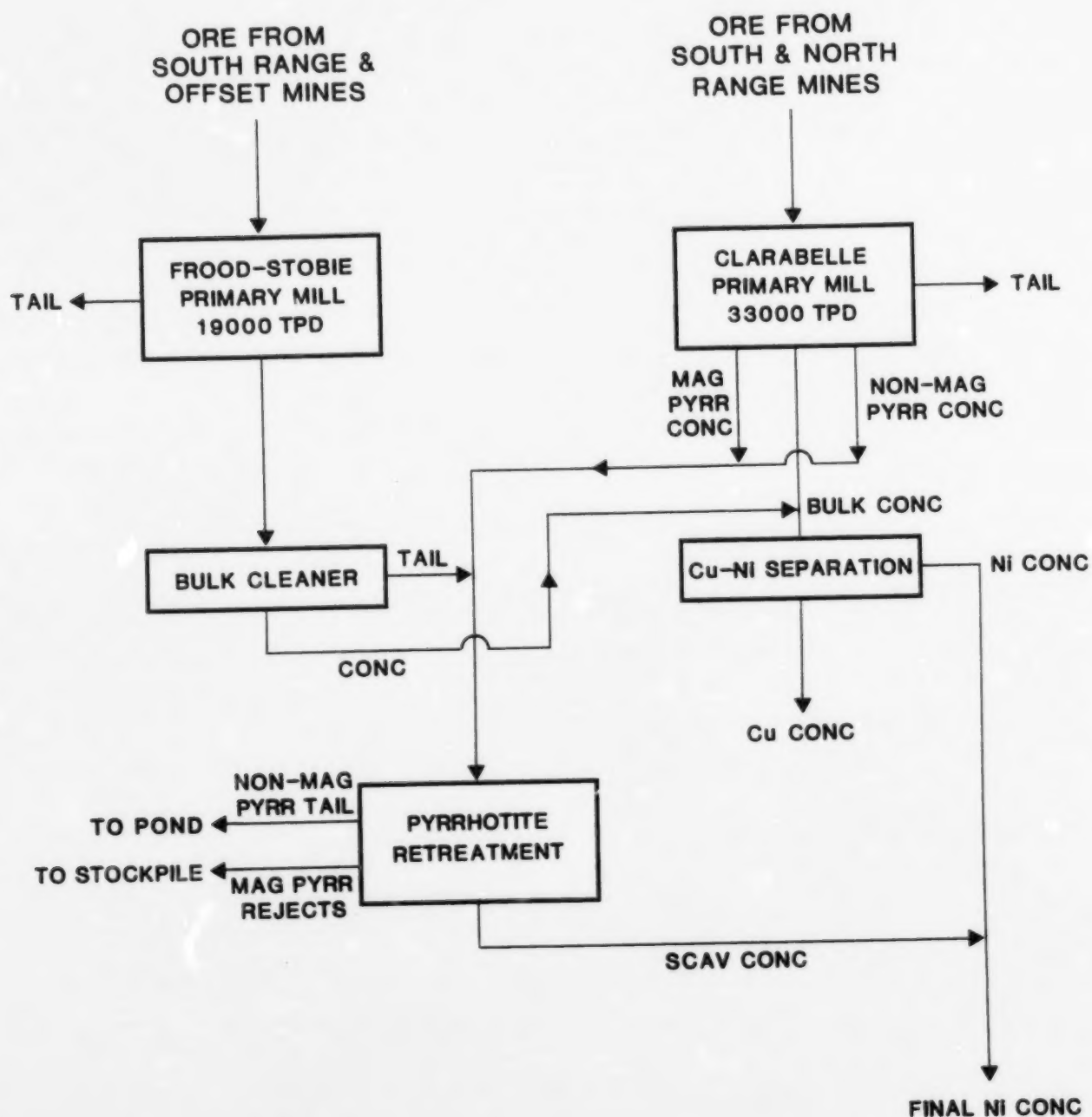
Nickel-copper concentration techniques at Falconbridge's Strathcona and Falconbridge mills are similar to those employed at Inco except that nickel-copper separation of the bulk concentrate is not carried out in the mill. At the Strathcona mill, the readily floatable free chalcopyrite is recovered in a high-grade copper concentrate prior to the flotation of the remaining copper and nickel into a bulk concentrate. PGE ore grades and recoveries of PGEs in the copper and bulk nickel-copper concentrates have not been published.

World

Merensky Reef Ore

In the Republic of South Africa a bulk sulphide flotation technique using a coarse grind of 40 to 50 per cent minus 74 micrometres (200 mesh) is employed for concentrating the platinum-group minerals in the Merensky Reef

FIGURE 1
SIMPLIFIED FLOWSHEET OF INCO COPPER CLIFF
SECONDARY MILL INTEGRATED WITH
PRIMARY FROOD-STOBIE AND CLARABELLE MILLS



ore. From a representative mill grade of 7.4 g/t PGEs plus gold (Pt:Pd:Rh = 0.68:0.29:0.03), 82 to 85 per cent of the PGEs plus gold are recovered in a flotation concentrate assaying 66 g/t PGEs plus gold.

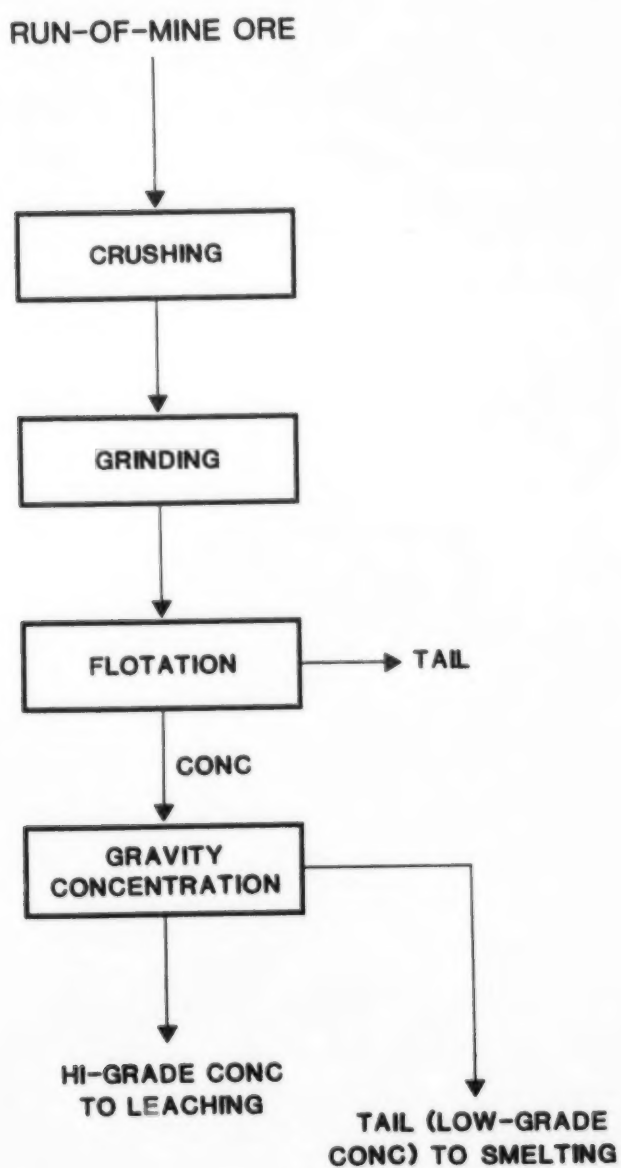
A typical simplified mill flowsheet is shown in Figure 2. As indicated, gravity concentration is employed to remove the heavier free PGE particles from the flotation concentrate. The high-grade gravity concentrate is sent directly to a leaching step, thus avoiding the higher treatment costs and losses associated with a smelting step.

In a mineralogical report by the South African National Institute for Metallurgy (now MINTEK), it was reported that during the concentration of Merensky Reef ores about 15 per cent of the PGEs were lost in flotation tailings. In their examination of one of the flotation tailings the Institute found that 54 per cent of the sulphide grains (mostly pyrrhotite) were free - also 59 per cent of the PGE losses were in the +150 micrometre (+100 mesh) fraction of the tailings in which only about 50 per cent of the sulphides were free. Because of the close association between PGEs and sulphides and because PGEs occur in the crystal lattices of pentlandite and pyrrhotite in the Merensky Reef ores, it was concluded that increased PGE recoveries could be achieved by more effective sulphide flotation and also by regrinding the coarse fraction (+180 micrometres) of the flotation tailings to liberate additional sulphides.

UG-2 Reef Ore

The UG-2 chromitite layer in the Bushveld complex of South Africa occurs from 30 to 400 m below the Merensky Reef. The PGMs (Platinum Group Minerals) of this zone are finer-grained and, as mentioned earlier, the distribution of individual PGEs is somewhat different. In addition the PGMs are predominantly associated with base metal sulphides or occur close by as discrete minerals enclosed by silicates. The amount of PGMs enclosed within chromite grains is generally very low (less than 12 per cent). In a full scale pre-production plant test on UG-2 Reef ore, Western Platinum produced a flotation concentrate assaying 362 g/t PGE with a recovery of 84.7 per cent from ore containing 5.23 g/t. Since start-up of the UG-2 concentrator at Western Platinum in March 1983, concentrate grades and recoveries have been marginally lower than those attained in the plant test.

FIGURE 2
TYPICAL FLOWSHEET FOR CONCENTRATION
OF MERENSKY REEF ORES



The Stillwater Complex - Montana, U.S.A.

The new Stillwater mine in Montana was designed to operate initially at 5004tpd (although actual throughput has been somewhat higher). Although the ore is mineralogically similar to the Merensky Reef of South Africa, it is of higher grade and has a significantly higher palladium to platinum ratio (3.5:1). Concentrate is produced by a bulk sulphide flotation technique and is shipped to Belgium for PGE extraction and refining.

The U.S. Bureau of Mines has carried out comprehensive batch and pilot-scale investigations on Stillwater Complex ore. Using the bulk sulphide flotation technique, the following results were achieved in the pilot plant:

<u>Ore Type</u>	<u>Conc. grade</u>		<u>Recovery</u>		<u>Calc'd feed grade</u>	
	<u>Pt</u> (g/t)	<u>Pd</u> (g/t)	<u>Pt</u> (%)	<u>Pd</u> (%)	<u>Pt</u> (g/t)	<u>Pd</u> (g/t)
Serpentinized	58	161	96	86	3.8	11.3
Anorthositic	38	120	91	87	3.8	12.0

On the serpentinized ore the collector combination of sodium isobutyl xanthate plus normal dodecyl mercaptan at a natural pH of 8.2 gave the best results while for the anorthositic ore, optimum results were obtained using mercaptabenzothiazole as the sole collector at an acid pH of 3.7.

Beneficiation Research

Some research has been done on flotation properties of PGE carriers at the University of Minnesota. The flotation behaviour of nickel arsenide, with which PGEs are associated in the Duluth Gabbro copper-nickel ores, was studied and was found to be improved by using an inert atmosphere and copper sulphate activation. In another investigation it was determined that galvanic contact between nickel arsenide and pyrrhotite improved the floatability of the former, but adversely affected the floatability of the latter.

Extraction/Refining of PGEs from Primary Sources

Canada

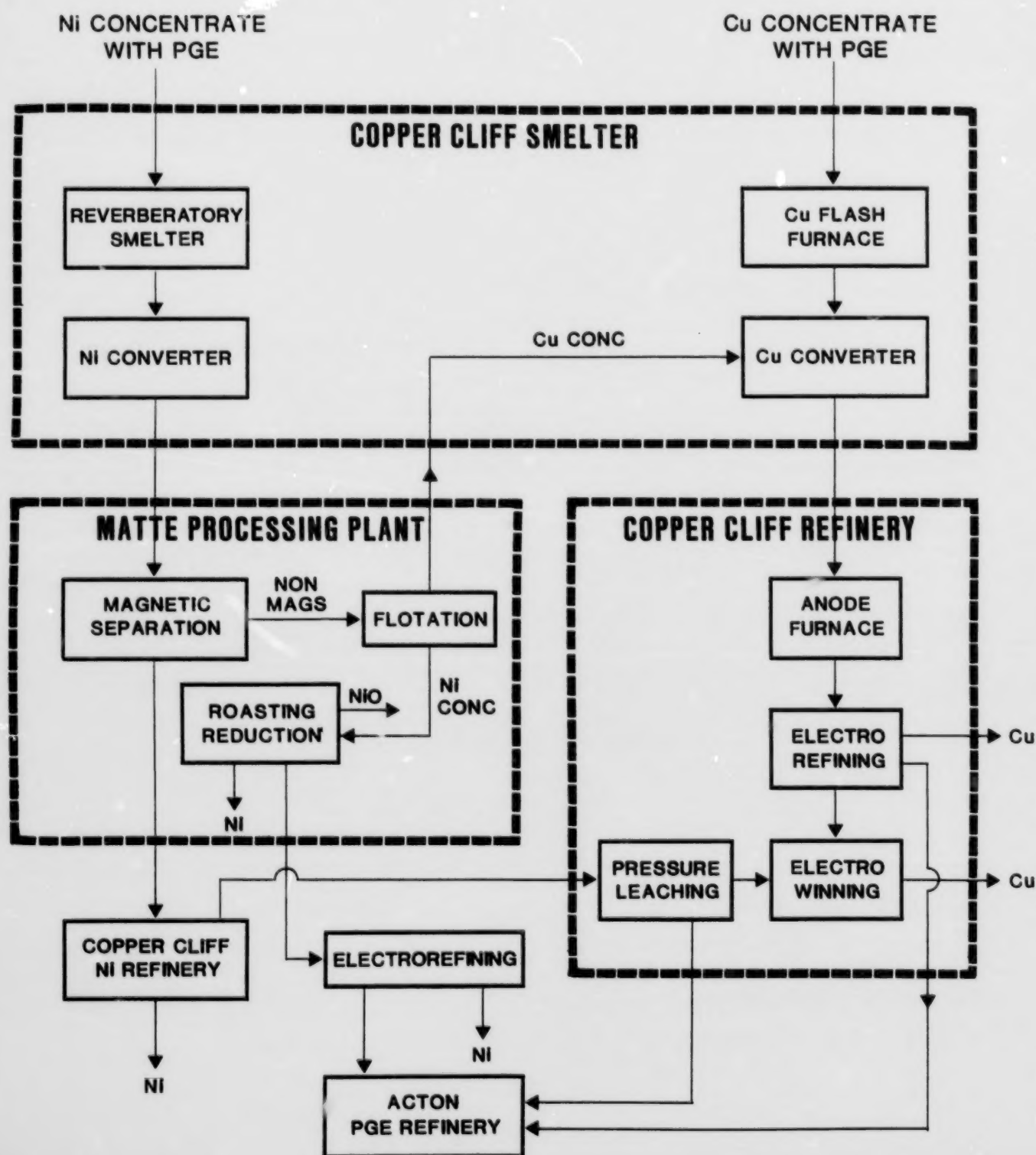
In Canada, PGEs are extracted from the Sudbury, Ontario nickel-copper concentrates at the Inco and Falconbridge smelters. At Inco, the nickel concentrate is partially roasted and then smelted in a reverberatory furnace to produce a nickel matte containing the PGEs. Further upgrading in converters yields high grade matte, which is cast into molds and slow cooled to produce a coarser grain size prior to treatment in the matte processing circuit. In this circuit magnetic separation and flotation are used to produce a magnetic concentrate containing most of the PGEs, and high grade nickel and copper concentrates. The magnetic concentrate is processed at the Copper Cliff nickel refinery to recover high purity nickel. Residues from the nickel refinery are pressure leached at the Copper Cliff copper refinery to recover residual copper, nickel and cobalt, and then shipped to Inco's Acton refinery in the U.K. to recover PGEs and other constituents.

The nickel concentrate from matte separation is roasted to produce nickel oxide for direct sale or for further reduction/refining to produce utility or high purity electro-refined nickel. Slimes from nickel electro-refining are also processed for PGE recovery at Acton.

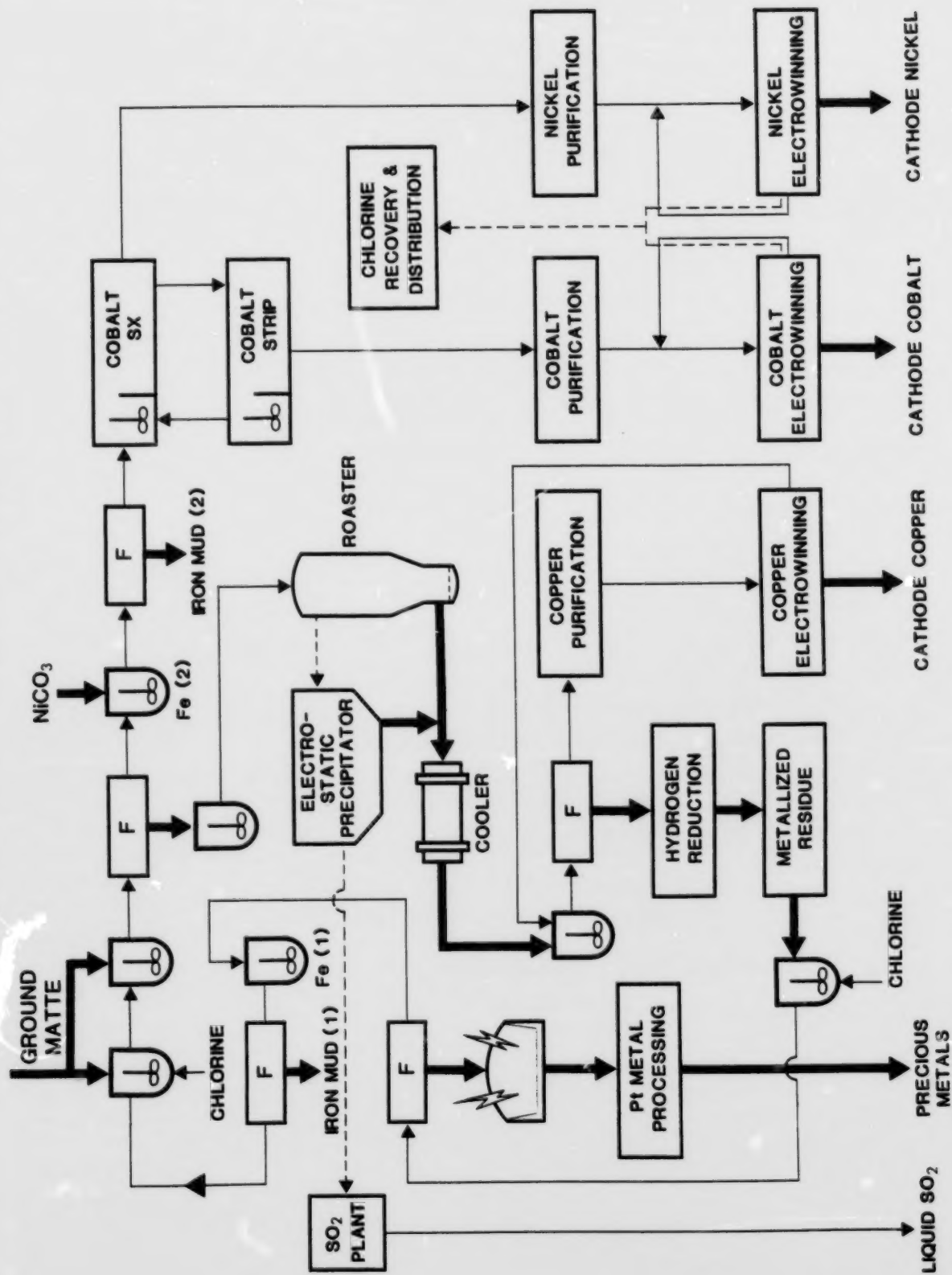
The copper concentrate from matte separation is processed in the Copper Cliff copper smelter along with the main copper concentrate from Inco's mills. The concentrates are flash smelted to produce a copper matte containing the PGEs and a discard slag. The matte is converted to blister copper in conventional converters and the copper is electrorefined to produce high purity copper cathodes. The slimes from electrorefining, containing the PGEs, are shipped to the Acton refinery. A simplified flow-sheet of the Inco Sudbury operations is shown in Figure 3.

At Falconbridge, the bulk nickel-copper concentrate is partially roasted and then smelted in an electric furnace to produce a matte and a discard slag. The matte is further upgraded in converters to produce a high grade nickel-copper matte containing the PGEs. This matte is shipped to Falconbridge's Kristiansand refinery in Norway, where nickel, copper and cobalt are recovered by a matte leach-purification-electrowin process in chloride media (Figure 4). Leach residues from this process are further treated to recover PGEs. Details of Falconbridge's PGE refining process have not been published.

FIGURE 3
INCO SUDBURY SMELTER/REFINERY



FALCONBRIDGE CHLORINE LEACH PROCESS



At Inco's Thompson, Manitoba plant, PGEs are recovered, along with copper, in the Thompson smelter in the form of a high grade nickel-copper matte which is shipped to Sudbury for treatment in the matte processing plant.

Overall recovery of PGEs in the Canadian nickel/copper smelters is greater than 95 per cent.

PGEs are also recovered from copper anode slimes at Canadian Copper Refiners Ltd. (CCR) in Montréal, Quebec, where copper produced at Noranda's Horne smelter is refined. The source of these PGEs can be copper and gold concentrates and/or metallic scrap processed at the copper smelter. Noranda recently installed a new hydrometallurgical processing system at CCR to separate PGEs from gold, and recover them in a bulk precipitate.

World

Most PGE producers outside of Canada refine PGEs from PGE-bearing matte, concentrates or anode slimes. South Africa's three refineries produce PGEs primarily from copper-nickel bearing mattes. Two of the producers (Impala Platinum Holdings Ltd. and Western Platinum Limited) use Sherritt Gordon pressure sulfuric acid leach technology to remove and recover copper, nickel and cobalt prior to PGE processing (Figures 5 and 6), and the third producer (Rustenburg Platinum Holdings Limited) uses a modified version of the Sherritt process.

The largest South Africa PGE refinery is Rustenburg's Wadeville plant at Germiston, with a capacity of close to 62 t/y. Rustenburg plans to replace this facility by 1989 with a new refinery utilizing solvent extraction technology (Solvex process) developed and subsequently utilized in a large-scale pilot plant at the Royston refinery in the U.K., owned by Matthey Rustenburg Refineries (Pty) Limited.

South Africa's second largest refinery is Impala's plant at Springs, with a capacity of 53 t/y. Solvent extraction techniques are used to separate and recover the PGEs from the Sherritt matte leach process residues, but details of the process technology have not been published.

The third PGE refinery, at Brakpan, with a capacity of about 15.5 t/y, processes base-metal refinery residues from Western Platinum Limited. The refinery is operated by Lonrho Refinery Ltd., a subsidiary of

FIGURE 5

SHERITT MATTE LEACH PROCESS IMPALA PLATINUM

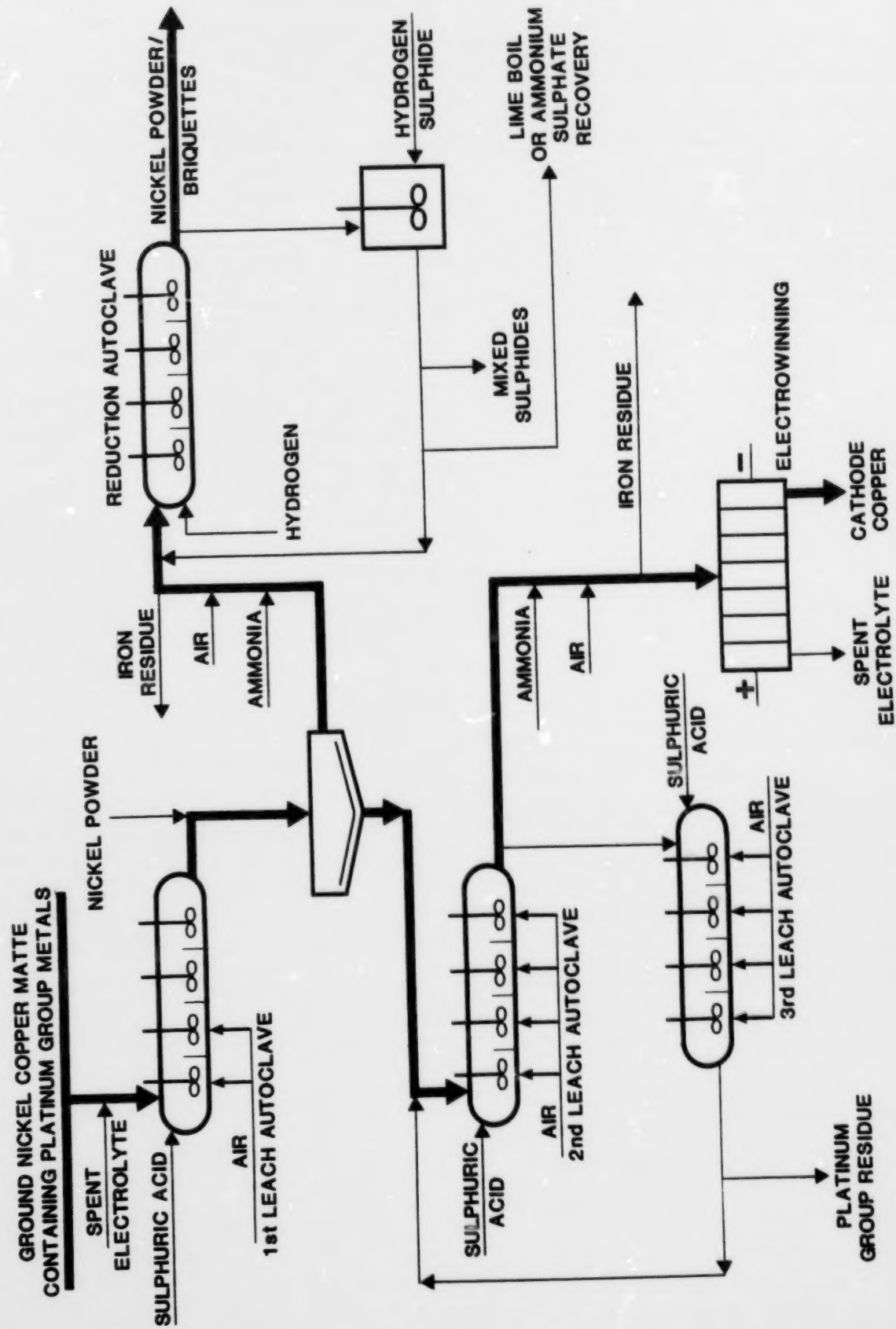
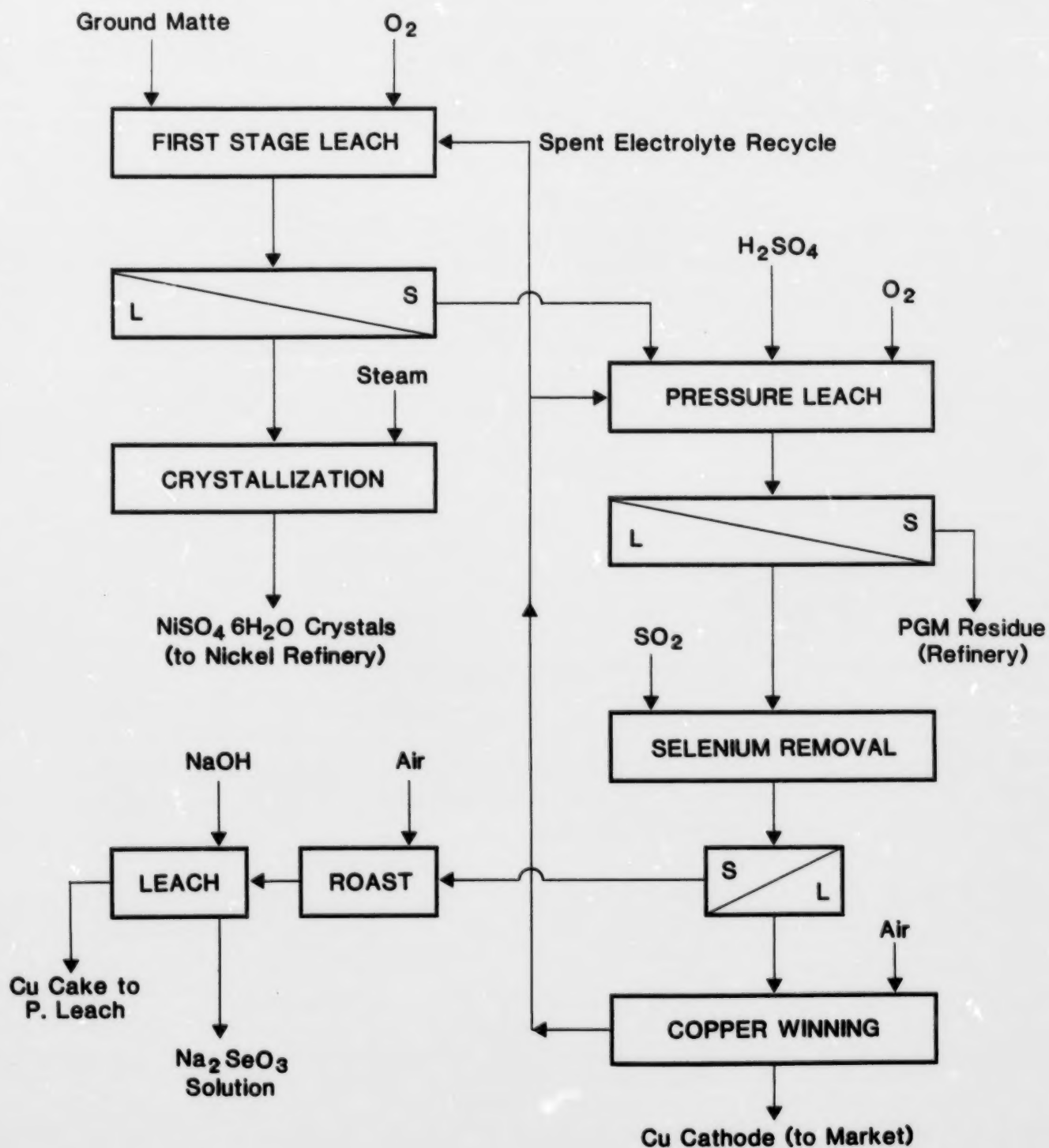


FIGURE 6

SHERRITT MATTE LEACH PROCESS WESTERN PLATINUM

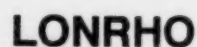


Western Platinum. Residues from matte leaching are subjected to a unique two stage reduction with carbon and then aluminum at 1200°C to produce a metallic aluminum alloy phase containing all of the PGEs and precious metals. The alloy is then leached with hot HCl to selectively dissolve the aluminum and base metals. The residue containing all of the PGEs, gold and silver is dissolved in HCl/Cl₂ and gold and silver are recovered by reduction/precipitation techniques and purified by conventional refining. Solvent extraction is used for bulk extraction of platinum and palladium, which are subsequently separated and recovered by chemical precipitation. Osmium is then recovered by selective distillation prior to solvent extraction to remove ruthenium, which is recovered by precipitation as a hydrated oxide. Ion exchange is used to extract iridium, which is further purified by solvent extraction prior to recovery by chemical precipitation. Finally, rhodium is recovered from the leach liquor by precipitation and reduction. All of the PGEs are eventually recovered in relatively pure metallic form by hydrogen reduction or thermal decomposition of the as-produced or calcined chemical precipitates. A simplified flowsheet of the Lonrho refinery is shown in Figure 7.

In addition to the South African refineries there are two refineries in the U.K., two elsewhere in Europe and one in Japan that produce the remainder of the Western world's refined PGEs from primary sources. The largest refineries outside of South Africa are Inco's Acton refinery and Matthey Rustenburg's Royston refinery, both in the U.K. Capacities are estimated at 11 t/y and 16 t/y, respectively.

The Acton refinery utilizes a two stage HCl/Cl₂ leach to dissolve PGEs, gold, silver and base metals from Inco's nickel/copper refinery slimes and residues. Silver is recovered by chemical precipitation and purified by conventional refining. Osmium and ruthenium are recovered by distillation, followed by selective condensation and precipitation to separate the ruthenium. Gold, platinum and palladium are extracted and separated by selective solvent extraction techniques. Gold is recovered by reduction and conventional refining, while platinum and palladium are recovered by chemical precipitation from the stripped solvents. Rhodium and iridium are separated by selective chemical precipitation. All of the PGEs are

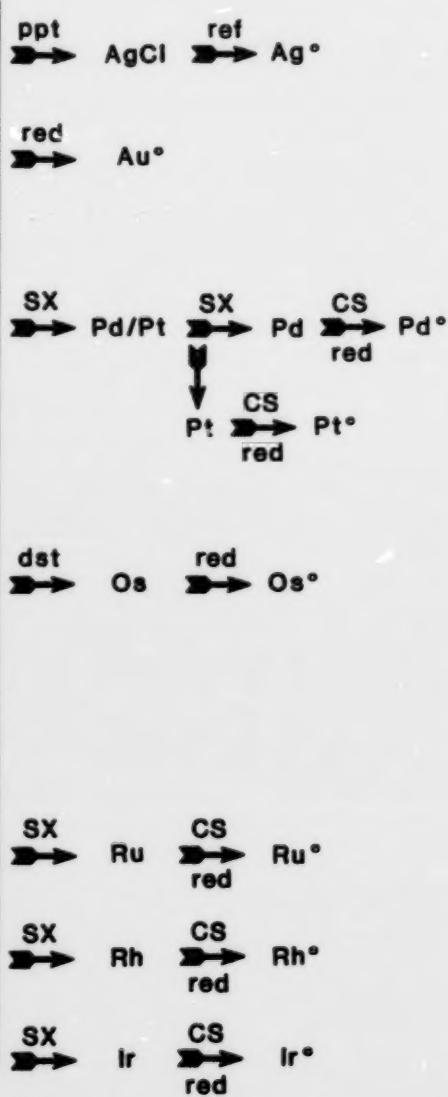
FIGURE 7



PGE CONCENTRATE

AI ALLOY

Cl₂, HCl LEACH



CS CHEMICAL SEPARATION
SX SOLVENT EXTRACTION
IX ION EXCHANGE

recovered in pure metallic form by hydrogen reduction or thermal decomposition of the chemical precipitates.

A simplified flowsheet of the Acton refinery is shown in Figure 7. For rhodium and iridium separation and recovery, Inco is presently developing a solvent extraction system to replace chemical precipitation.

The Royston refinery utilizes a single stage HCl/Cl_2 extraction system for treating PGE bearing concentrates and matte leach residues. Silver is recovered by chemical precipitation and conventional refining. Solvent extraction is used to extract gold and base metals from the leach solution and gold is recovered by ferrous iron reduction and conventional refining. The raffinate from this step, containing all the PGEs, is subjected to selective solvent extraction steps to separate and recover palladium, platinum and iridium. Osmium and ruthenium are recovered by distillation in the same manner as at Acton, but after (rather than before) palladium separation and recovery. Finally, rhodium is separated by ion exchange. All of the PGEs are recovered by hydrogen reduction or thermal decomposition of chemical precipitates, in a manner similar to Acton and Lonrho. A simplified flowsheet of the Royston refinery is also shown in Figure 7 for comparison with the Acton and Lonrho refineries.

Metallurgie Hoboken-Overpelt S.A.'s (HBO) PGE refinery in Belgium produces refined gold and PGEs from HBO's silver refinery anode slimes. Scrap is the source of most PGE feed but the plant began treating concentrates from the Stillwater mine in 1987. Capacity is estimated to be about 9 t/y. The slimes are leached in nitric acid to dissolve silver, palladium, iridium, rhodium and about 10 per cent of the platinum. After denitration, silver is selectively leached and the remaining PGE oxides are redissolved in HCl and separated by solvent extraction and chemical precipitation. The nitric acid leach residue containing the gold and most of the platinum is chlorine leached, gold is recovered by electrolysis and platinum is recovered from the spent electrolyte by chemical precipitation. Again all of the PGEs are recovered in pure metallic form by hydrogen reduction or thermal decomposition of the chemical precipitates.

Outokumpu Oy's refinery in Finland recovers gold, silver and PGEs from copper refinery anode slimes. After leaching and roasting to remove nickel and selenium, the slimes are smelted to produce a doré-metal, and

PGEs, mainly platinum and palladium, are recovered by precipitation from the silver and gold refinery electrolytes. Sumitomo Metal Mining Co. Ltd. in Japan also produces gold and PGEs from copper anode slimes by a roast-leach-selective precipitation process. As far as is known, neither Outokumpu nor Sumitomo produce refined individual PGEs and their plants are relatively small (less than 1 t/y).

Little information is available on PGE refineries in the USSR. The technology used, however, appears to be similar to that at western refineries. Leaching is carried out in HCl/Cl_2 media, and solvent extraction techniques are used for gold and PGE extraction and separation. In some cases, leaching is carried out under pressure to improve extraction, and platinum and palladium are recovered directly from the organic phase by hydrogen reduction.

Extraction/Refining of PGEs from Secondary Sources

World

Since 1975, the automotive industry has been a major consumer of platinum and palladium for use in catalytic converters. It is estimated that up to 3 700 kg/y of PGEs may be recovered in the USA alone from this secondary source. Other secondary sources of PGEs include electrical-electronic scrap, catalysts from the petro-chemical, ceramic and glass industries and jewellery, dental and medical scrap.

Recovery of PGEs from secondary sources takes place mainly through the smelters and refineries processing the primary sources. Recovery from catalytic converters, however, has resulted in the development of new facilities and processing techniques designed specifically for this secondary source. In the USA, four different processes are used by a number of companies engaged in the processing of used auto catalysts. While some companies are involved only in the removal of PGE-bearing materials, others produce an upgraded material that is ready for final refining.

Texasgulf Inc., which is by far the largest auto catalyst recycler, operates a large processing facility at Anniston, Alabama that uses plasma arc smelting to produce a PGE-iron alloy. This alloy is granulated and

leached with $\text{H}_2\text{SO}_4/\text{HCl}$ and the leach residue containing the PGEs is shipped to a refinery for further treatment.

Another company, Gemini Industries Inc. of Santa Anna, California, uses sulfuric acid to dissolve the substrate materials and recover a saleable aluminum sulfate. The PGEs in the leach residue are further treated to separate and recover platinum, palladium and rhodium.

In West Germany, Degussa A.G. has a relatively large refinery with a capacity of about 15 t/y which produces refined PGEs using solvent extraction separation/purification techniques. Feed to the plant is believed to be mainly from secondary sources. PGEs recovered include platinum, palladium, rhodium and iridium.

New Process Development in Canada

A new process for treating catalytic converter scrap, developed at McGill University, may be brought to commercial production through the construction of a new processing facility in Quebec. Leaching is carried out in an $\text{HCl}/\text{HNO}_3/\text{AlCl}_3$ media and platinum and palladium are recovered by ion exchange. Aluminum and lead are also recovered as sulphate and chloride, respectively.

At CANMET, a solvent extraction/selective stripping process has been developed for the recovery and separation of PGEs from leach solutions containing gold and base metals. Industry has expressed interest in the process for the possible establishment of refining facilities in Canada to recover high purity PGEs. Noranda has already taken the initiative in this regard, with their recently installed hydrometallurgical processing system at CCR. If future plans are successful, it could result in Canada's first PGE refinery.

There is little doubt that the development of superior technologies for separating and purifying PGEs will facilitate the establishment of new plants in Canada to produce refined PGEs from both primary and secondary sources.

APPENDIX 1

NATIONAL MINERAL INVENTORY

Persons interested in exploring for platinum metals in Canada may consult the National Mineral Inventory (NMI) of the Mineral Policy Sector, which is responsible within EMR for distributing mineral occurrence information to the public.

NMI maintains a growing inventory, currently comprising, on cards, comprehensive descriptions of more than 20,000 Canadian mineral occurrences. The cards contain detailed history of work, including exploration, development and production, resource determinations, and ownership. Also included are a geological description, data on location and references. Photocopies of the cards are available at 25¢ per two-sided sheet.

NMI also has a computerized index of 28,000 occurrences (which includes the 20,000 mentioned above). The computerized portion contains only key identifying and descriptive characteristics, such as name of deposit, location, development status and geological type. The computer index can print out a list of say all the recorded Canadian occurrences of platinum metals and of nickel. By including nickel, such a list would cover most potential platinum metal occurrences in the inventory. Custom printouts are available for \$10.00 per printout plus 10¢ per page. Thus, a recently printed out index of "Platinum Metal and Nickel Occurrences in Canada" had 34 pages and cost \$13.40.

Visitors are welcome to the NMI fileroom to view the mineral occurrence files in person. Orders for photocopies of cards or computer printouts can be made also by telephone or letter, addressed to:

National Mineral Inventory,
Mineral Policy Sector,
Energy, Mines and Resources Canada,
11th Floor, 580 Booth Street
Ottawa, Canada K1A 0E4

Telephone: (613) 995-9466

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